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THE STATUS OF PLANT PATHOLOGY IN PORTO RICO

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THE STATUS OF PLANT PATHOLOGY IN PORTO RICO.

By MELVILLE T. COOK.

Within the past half century, the study of the causes of plant diseases and methods for their control, has risen from an insignificant phase of botany to one of the most important subjects of agriculture. Plant diseases are referred to in the early writings of the Greeks, Romans and other ancient peoples but their observations cannot be said to constitute the beginnings of plant pathology. No very great progress was made until the invention and development of the microscope, during the sixteenth century, made it possible to study minute organisms. The period from the early part of the sixteenth to the latter part of the nineteenth centuries was marked by the rise of mycology, that branch of botany which was to be the corner stone of our modern plant pathology. The nineteenth century also saw the remarkably rapid rise of that sister science, bacteriology, under the direction of the master mind of Pasteur.

Plant pathology grew out of mycology during the latter half of the nineteenth century but bacteriology and other sciences have contributed to its rapid development. It is by means of these sciences that we are able to explain the causes of many diseases of plants and to determine the character and time of the treatment. The early efforts to control plant diseases were influenced by ignorance, superstition and the religious ideas of the times. The first great step in the control of diseases was made in 1882 when Millardet of Bordeaux, France, demonstrated the possibilities of a fungicide which has been greatly improved and is now known as "Bordeaux mixture."

During the last half of the nineteenth century many botanists in the United States were devoting the major part of their time to

the study of fungi; and many others, especially those connected with the agricultural colleges and agricultural experiment stations, were studying the causes of, and control of plant diseases. The natural outcome of these studies was the formation of departments of plant pathology in many colleges and universities and finally the organization of the American Phytopathological Society in 1909. Plant pathology was soon recognized as a most important science with a direct bearing on the economic welfare of the people. It was during this period of intense interest in the new science that the Spanish-American war was fought and Porto Rico became an integral part of the United States. Agriculture being the industry of primary importance in Porto Rico, the new science was called on to play an important part in the agricultural and educational policies of the United States Government in the new territory.

The contributions to our knowledge of mycology in the American Tropics previous to this time were few and imperfect. Some few collectors from both Europe and America had visited the Tropics and made collections of taxonomic importance; some resident workers had made contributions; and specimens which were sent to Kew Botanical Garden and other botanical centers had been the subjects of a number of papers. Although very few of these studies were made in Porto Rico or on Porto Rican material, they are of more or less interest in studying the mycological and pathological problems of the Island.

Porto Rico became a part of the United States at a time when plant pathology was just beginning to be recognized throughout the world as a most important science; at a time when plant pathology was just entering a period of great development in the United States. At this time there were no professorships of plant pathology in the United States but a number of departments of botany were giving courses in the subject and a number of agricultural experiment station workers were studying the control of plant diseases. The result was that Porto Rico received the benefits of this new movement and the importance of investigations in the mycology and plant pathology of the Island was immediately recognized as a part of the policy of the United States Department of Agriculture. The establishment of the Agricultural Experiment Station at Mayagüez (1900) gave immediate recognition to the importance of research; and the establishment of the College of Agriculture at the same place (1911) gave the youth of the Island an opportunity to study this most important subject. The sugar growers of the Island were

FIG. 1.—Map showing the elevation. This map was obtained from the U. S. Weather Bureau office in San Juan. The elevations are from the same and other sources.

not slow to recognize, among their other problems, the very large losses due to plant diseases and the necessity for research along these lines. Therefore, they established the Sugar Planters Experiment Station at Río Piedras in 1910 which became the Insular Experiment Station in 1917. But the work of these three institutions does not tell the complete story of the rise of mycology and plant pathology in Porto Rico. Many scientific workers in the United States were interested in the Tropics in general and especially in Porto Rico and several of them have visited the Island from time to time and made more or less extensive studies.

Before taking up a discussion of the work of these institutions and men, it is desirable to give some attention to climate, topography and agricultural crops of the Island. Porto Rico is almost rectangular in form, about 100 miles east and west and 36 miles north and south and therefore consists of approximately 3,600 square miles, which at this time supports a population of 1,300,000 or more. It is very mountainous, some peaks reaching a height of 3,500 or 4,000 feet. The main mountain chain extends east and west and the water shed is about 10 or 12 miles north of the south coast but curving in a northeastern direction near the east end and extending almost to the north coast. Approximately two-thirds of the Island lies north of the water shed. This ridge or water shed gradually increases in altitude from its western extremity to Adjuntas where it is approximately 2,000 feet in height. This elevation is maintained to Aibonito. From this point the elevation gradually drops to about 500 feet. This altitude is maintained until near El Yunque at which point it rises rapidly to about 3,600 feet. El Yunque is usually referred to as the highest point on the Island but it is claimed by some that the highest point is near Los Picachos which is said to be about 4,300 feet. Numerous smaller ranges branch off to the north and south from this main range. Most of the rivers run north or south dependent on whether they are north or south of the principal range, the longer and larger being on the north coast Of course the rivers are in the valleys between these north and south ranges; the larger and longer ones flow north while the shorter ones flow south. There are 51 rivers and more than 3,000 smaller streams, but none of them navigable; in fact the larger ones can scarcely be dignified by the name of "river," except during the periods of high water, when they become mountain torrents. The character of soil varies greatly; in some places it is derived primarily from the igneous rock while in other places it

FIG. 2.—Map showing the mean annual temperature from 1899 to 1923. Obtained from the U. S. Weather Bureau Office in San Juan.

has evolved from the lime-stone formations. To these must be added the coastal plains and the numerous mixtures.

The prevailing winds in this part of the world are from east and northeast and the regularity is surprising to the visitors from the States. They are important factors in relation to the temperature and rainfall. The air is practically saturated at all times.

The average annual temperature for the coastal plains for a period of twenty-four years was 78°; for the elevations of 2,000 to 3,000 feet it was 72°. (See figure 2). During the same period the extremes of temperature were from 51° in some of the highest points to 94° in some of coastal regions. Although the temperature is somewhat higher during the summer than during the winter it is remarkably uniform throughout the year.

The rainfall depends on the heat which carries the moisture upward into the colder strata of air, thus bringing about precipitation. The moisture is carried in by the winds from the east and northeast until it is checked by the mountains, rises into the colder strata of air and falls as rain. The result is the excessive rainfall in that part of the Island north of the water shed. A study of the map (Fig. 3) will show this point and also that the rainfall is correlated with the elevations.

These variations in elevation, temperature and rainfall give most striking variations in vegetation; that on the north side being abundant and tropical in character while that on the south side is characteristic of warm, semi-arid regions. In fact in some places, especially in the southwestern part, the country is almost barren for long periods except for cacti. However, agriculture is practiced very generally on the south side with the aid of irrigation. In some places the transition from a vegetation of the luxuriant type, characteristic of high temperature and heavy rainfall, to that of the warm, semi-arid regions occurs within the very short space of two or three hundred yards. When we look upon this wonderful display of mountain scenery, of fertile valleys and of rich, varied vegetation, we are not surprised that the late President Roosevelt called it "the Switzerland of America," although it is without the snowy peaks of that "wonder land."

The principal crops are: sugar cane which is value at nearly one-half the total agricultural interest of the Island; coffee, amounting to more than one-sixth; fruits and coconuts amounting to about one-ninth and tobacco amounting to about one-eleventh.[1]

[1] According to the U. S. Census Report for 1920, the 1919 production was:

The sugar cane is grown in the coastal and alluvial plains and in the rich valleys. It is also grown to some extent in the hills, especially in the eastern part of the Island. On the south side this production is carried on largely by means of irrigation. It almost completely girdles the Island. The coffee is grown in the higher elevations, the greatest production being in the western half of the Island. The fruits are scattered throughout the Island, the most important citrus district being in the vicinity of Bayamón which is south of San Juan. The coconuts are found in all parts of the Island but are most abundant along the sea-coast. The tobacco-growing industry is most important in the east central part of the Island; in a region extending from Juncos on the east to Naranjito and Aibonito on the west. Forage crops of various kinds are grown quite extensively throughout the Island for the feeding of livestock. However, there are many other crops grown on a small scale, such as cotton, rice and fruits of various kinds. The Island also produced surprising large quantities of wild fruits.

Although the difference in temperature in different parts of the Island are comparatively slight, it will be readily seen that the variations in soil and rainfall make possible the growing of a great variety of crops and a very rich tropical flora. All these conditions are favorable for the production of fungi and plant diseases.

The development of plant pathology in Porto Rico naturally falls into two divisions: the period under Spanish rule and the period since the Island became a part of the United States—twenty five years ago, July, 1923.

The work of the period under Spanish rule has been stated by Stevenson[1] as follows:

"The earliest recorded collection of the fungi of Porto Rico was made in 1854 by Carl Schwanecke, for the most part in the vicinity of Humacao and the specimens were determined by Klotzsh, who listed them in Linnaea.[2] It was not until 1884–87 that further collections were made, during which period P.

Sugar Cane	$31, 808, 880
Coffee	11, 707, 391
Fruits and coconuts	7, 074. 429
Tobacco	5, 599, 678
Vegetables	4, 340, 247
Cereals	1, 392, 591
Other seed crops	1, 007, 582
Grass and forage	730, 018
Cotton, etc.	201, 362
	$63, 862, 178

[1] Stevenson, John A.—A Check List of Porto Rican Fungi and a Host Index. The Journal of the Department of Agriculture of Porto Rico. 2: 125–264. (July 1918).

[2] Klotzsch, J. Schwanecke.—Collection of fungi. In Linnaea, 25: 364–366 (1852).

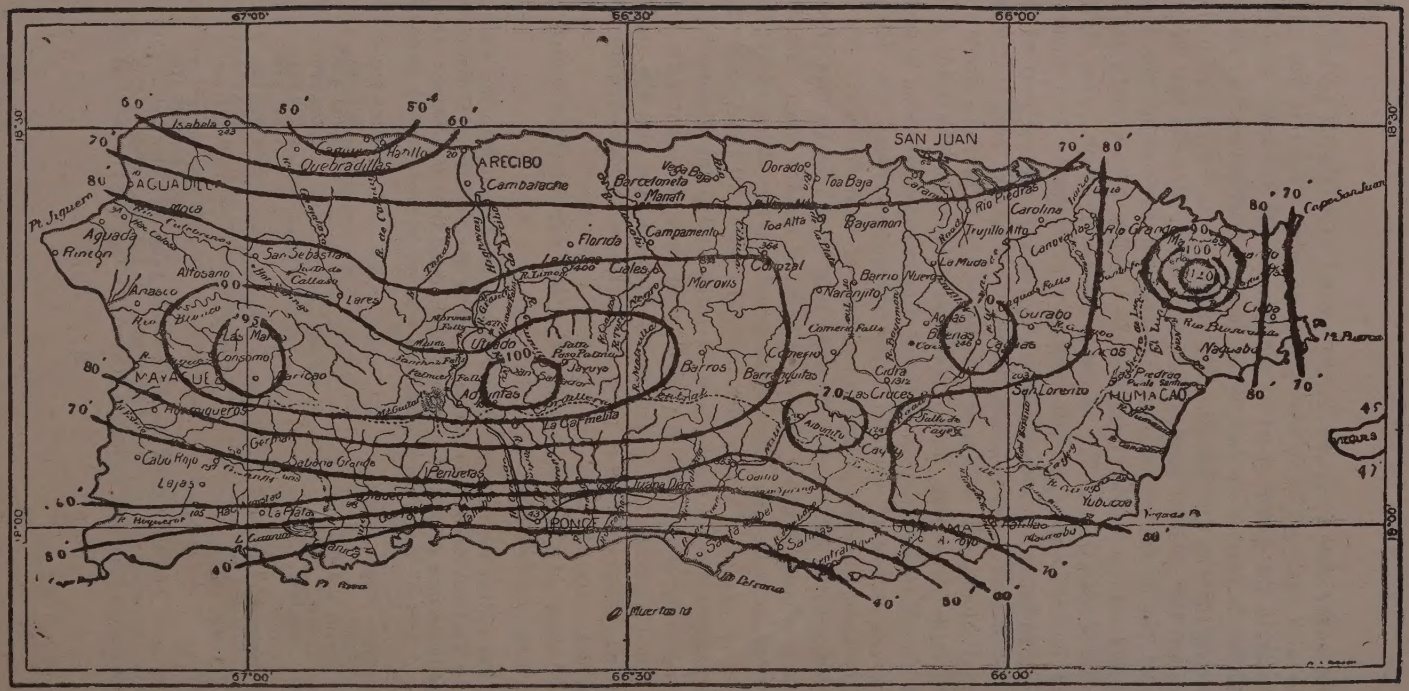

FIG. 3.—Map showing the mean annual rainfall from 1899 to 1920. Obtained from the U. S. Weather Bureau office in San Juan.

Sintenis visited various parts of the Island. The fungi gathered by him were worked over by J. Bresadola, P. Hennings and P. Magnus and their determinations were published in 1893.[1] A recompilation of these two lists was given by Heller[2] in 1900."

To these publications we should probably add "Informe Dado a la Excelentísima Diputación Provincial sobre la Enfermedad de la Caña de Azúcar, en el 4º. Departamento de la Isla de Puerto Rico por los Comisionados al Efecto Doctores, D. C. Grivot Grand-Court y D. Agustín Stahl y el Licenciado D. José J. Acosta y Calbo." (June 1878). This publication does not mention fungi and it is probably that some of the troubles to which it refers were caused by insects.

The second period began soon after the American occupation (1898) and at a time when plant pathology was emerging from botany and developing into a separate, if not distinct branch of study and research. Those who have served as plant pathologist on the Island since that date are as follows:

Agricultural Experiment Station at Mayagüez:

1. O. W. Barrett, Botanist and Entomologist—1901–05.
2. W. V. Tower, Entomologist and Plant Pathologist—1906–07.
3. G. L. Fawcett, Plant Pathologist—1908–14.
4. E. W. Brandes, Plant Pathologist—1915–16.
5. L. R. Hesler, Plant Pathologist—1917.
6. E. H. Thomas, Plant Pathologist—1917–18.
7. C. M. Tucker, Plant Pathologist—1923.

Agricultural College, at Mayagüez:

1. F. L. Stevens, Dean—1912–14.
2. A. Fredholm, Prof. of Plant Pathology—1915–20.
3. C. M. Tucker, Prof. of Plant Pathology—1920–23.
4. B. A. Bourne, Prof. of Plant Pathology—1923.

Insular Experiment Station (Formerly Sugar Growers' Experiment Station) at Río Piedras:

1. J. R. Johnston, Plant Pathologist—1910–14.
2. John A. Stevenson (with R. C. Rose, J. R. Johnson and J. Matz, Assistants)—1913–18.
3. J. Matz (with B. López, Assistant)—1918–23.
4. F. S. Earle, Expert in cane diseases[3]—1919–21.
5. C. E. Chardón, Special Plant Pathologist for the study of sugar cane mosaic—1921–22.
6. C. E. Chardón, Expert on cane diseases—1922–23.
7. Melville T. Cook (with R. A. Toro, Assistant)—1923.

In 1918, Stevenson published his "Check List of Porto Rican

[1] Sintenis, P. Pilzen auf der insel Portorico 1884–1887 gasammelten. In Engler. Bot. Jahrb. 17: 489–501 (1893).

[2] Heller, A. A.—Some Porto Ricna Fungi. In Muhlernbergia. 1: 18–19 (1900).

[3] F. S. Earle had served from 1918–1919 as special agent from the U. S. Department of Agriculture for the study of sugar-cane diseases.

Fungi and a Host Index," which is very complete and valuable. He cited 105 publications which are of more or less importance in the study of the fungi and plant diseases of Porto Rico. Since the publication of this work, twenty seven additional papers have been published as follows:[1]

(1) Stevens, F. L.—Some meliolicolous parasites and commensals from Porto Rico, Bot. Gaz. 65: 227–249, pl. V–VI fig. 1–5, (March 1918).
(2) Fink, Bruce.—The distribution of fungi in Porto Rico, Myc. 5: 58–61, (March 1918).
(3) Burt, E. A.—Corticiums causing Pelicularia disease of the coffee plant, Hypochnose of Pomaceous fruits and Rhyzoctonia diseases, Annals of Mo. Bot. Garden 5: 119–132, (April 1918).
(4) Fitzpatrick, H. M.—Restronitschkia, a new genus of Pyrenomycetes Myc. 11: 163–167, pl. II, (July 1919).
(5) Stevens, F. L. and Dalbey, Nora.—Some Phyllachoras from Porto Rico Bot. Gaz. 68: 54–59, pl. IV–VIII, (July 1919).
(6) Stevens, F. L.—Dothidiaceous and other Porto Rican fungi, Bot. Gaz. 69: 248–257, pl. XLII–XIV, (March 1920).
(7) Seaver, F. J.—Notes on North American Hypocreales—IV Aschersonia and Hypocrella, Myc. 12: 93–97, pl. 6, (March 1920).
(8) Fitzpatrick, H. M.—Monograph of the Coryneliaceae, Myc. 12: 206–237, pl. 12–18 (July 1920), and Myc. 12: 237–267, (September 1920).
(9) Chardón, C. E.—A list of the Pyrenomycetes of Porto Rico collected by H. H. Whetzel and E. W. Olive, Myc. 12: 316–321, (November 1920).
———.—A contribution to our knowledge of the Pyrenomycetes of Porto Rico, Myc. 13: 279–300, fig. 1–4, pl. 13–15, (November 1921).
(10) Matz, Julius.—The Rhizoctonias of Porto Rico, Journal of the Department of Agriculture and Labor, 5: 5–30, fig. 1–28, (January 1921).
(11) ———.—Enfermedad de la raíz de la caña de azúcar, Rev. de Agricultura de Puerto Rico. 2: 39–59. 1919.
(12) ———.—Algunas observaciones respecto a la sarna del citro en Puerto Rico, Rev. de Agricultura de Puerto Rico. 2: 40–41. 1919.
(13) ———.—Citrus spots and blemishes, Circ. 16, Ins. Experiment Station.
(14) ———.—Citrus and Pineapple fruit rots, Bul. 24. Ins. Exp. Sta.
(15) ———.—La enfermedad de la raíz del café, Circ. 32. Ins. Exp. Sta.
(16) ———.—Una enfermedad dañina de las habichuelas, Circ. 57. Ins. Exp. Sta.
(17) ———.—Salcocho de los semilleros de tabaco, Circ. 55. Ins. Exp. Sta.
(18) ———.—Various papers of the Investigations of sugar-cane diseases in Porto Rico, Journal of the Department of Agriculture and Labor, 6: 5–47. (July 1922).
(19) ———.—La gomosis de la caña de azúcar, Circ. 20. Ins. Exp. Sta.
(20) ———.—Infection and nature of the yellow-stripe disease of cane (Mosaic, Mottling, etc.). Journal of the Department of Agriculture and Labor of Porto Rico, 3: 65–82 (1919).
(21) ———.—Investigations of root diseases of sugar cane. Journal of the Department of Agriculture and Labor of Porto Rico, 4: 28–40 (1920).
(22) ———.—A new vascular organism in sugar cane. Journal of the Department of Agriculture and Labor of Porto Rico, 4: 41–46 (1920).

[1] This list does not include papers published in the *"Revista de Agricultura de Puerto Rico"* or trade journals.

(23) ———.—The Gumming disease of sugar cane. Memoirs of the Association of Sugar Technologists, 1: 18–21 (June 1922).
(24) Stevenson, John A.—The mottling or yellow stripe disease of sugar cane. Journ. of the Department of Agriculture and Labor of Porto Rico, 3: 3–76 (July 1919).
(25) ———.—An epiphytotic of cane disease in Porto Rico. Phytopathology 7: 418–425.
(26) Figueroa, C. A.—The mottling disease of cane and the sugar production of Porto Rico. Journal of the Department of Agriculture and Labor of Porto Rico, 3: 35–41 (1919).
(27) Colón, E. D.—The absorption spectrum of the chlorophyll in yellow-stripe sugar cane. Journ. of the Department of Agriculture and Labor of Porto Rico, 3: 43–46 (1919).
(28) López Domínguez, F. A.—Has yellow stripe or mottling disease any effect on the sugar content of cane juice. Journ. of the Department of Agriculture and Labor of Porto Rico, 3: 47–64.
(29) Smyth, E. Graywood.—Insects and mottling disease. Journ. of the Department of Agriculture and Labor of Porto Rico, 3: 83–117 (1919).
(30) Chardón, C. E., y Veve, R. A.—The Transmission of Cane Mosaic. The role of Aphis Maidis in Spreading the disease under field conditions in Porto Rico. Memoirs of the Assoc. of Sugar Techn. of P. R. 1: 9–12, June 1922. Also in Phytop 1: 24–29. 1923.
(31) Earle, F. S.—El mosaico de la caña o matizado, Circ. 22. Ins. Exp. Sta.
(32) Earle, F. S.—The year's experience with sugar cane mosaic or yellow-stripe disease, Journal of the Department of Agriculture and Labor. 3: 3–150. Oct. 1919.
(33) ———.—Sugar cane root disease, Journal of the Department of Agriculture and Labor, 4: 3–27 (1920).
(34) ———.—Eradication as a means of control in sugar cane mosaic or yellow stripe, Bul. 22. Ins. Exp. Sta.
(35) Stevens, F. L., and Dalby, Nora A.—A Parasite of the tree fern (Cyathea) Bot. Gaz. 68: 222–225, Sept. 1919.
(36) Tehon, L. R.—Studies of some Porto Rican fungi, Bot. Gaz. 67: 501–511, pl. 18, (1919).

One hundred and thirty nine publications within the past twenty-five years deal more or less directly with the mycology and plant pathology of Porto Rico and nearly all of them are the results of studies made on the Island or of material recently collected on the Island. However, it is very doubtful if anything more than a beginning has been made in the taxonomic study of the fungi of Porto Rico. The study of the life history of fungi presents an extremely fascinating field which can be pursued both in an out of the laboratory for the entire year. In fact these studies must be pursued continuously for long periods of time if the best results are to be obtained. For although the climatic variations are comparatively slight throughout the year, many of the fungi have periodic seasons of growth and then disappear. The more intensive study of the fungi which attack both the indigenous and introduced

wild vegetation will not only add to our knowledge of the mycology of the Island but will no doubt give great aid to the study of the diseases of the Island crops. The diseases of our crops are causing heavy losses which are as yet not fully appreciated but which must be checked if our agriculture is to reach its highest development. The disease which has attracted the greatest attention of the public during the past few years is the mosaic of the sugar cane. This disease was first reported in Porto Rico in 1915 and has been and is at this time the cause of very heavy losses. It is without doubt the most important plant disease on the Island and has done more than any other agency to attract the attention of the public to the very great importance of plant diseases. Many people appreciate the enormous losses resulting from this disease while many others are blind to its ravages. The masterly work of Prof. F. S. Earle has demonstrated that this disease can be controlled economically. However, many do not appear to appreciate his methods and a campaign of education must be conducted before our losses from this cause will be greatly reduced. Furthermore, the cause of mosaic remains a problem for future study. The root-rot problems of the sugar cane are practically untouched, although secondary in importance only to the mosaic. The gummosis of the sugar cane is another important problem which is not fully solved. Although tobacco diseases have been studied in many parts of the world, very little attention has been given to them in Porto Rico. The coffee diseases have been the subjects of excellent studies from the Agricultural Experiment Station at Mayagüez, but much work remains to be done. The general appearance of our citrus fruits shows that much remains to be done in the control of diseases before we can put the maximum amount of the highest grade fruit on the northern markets. That our knowledge of pineapple disease is very imperfect is evident to any one who has made a careful examination of the literature. It is very evident that the maximum agricultural production on the Island depends in a great measure on our knowledge of and our ability to control the many diseases of plants which are due to fungi, bacteria and other causes. The easy problems have been solved; many of the problems of the future will require the most careful laboratory technique and most thorough field technology in various lines of agriculture.

The writer wishes to express his thanks to Dr. O. L. Fassig and Mr. Geo. V. Sager of the U. S. Weather Bureau Office in San Juan for the maps and for data on temperature and rainfall.